# Rhodora

JOURNAL OF

THE NEW ENGLAND BOTANICAL CLUB

Vol. 52. June, 1950 No. 618


## AN ELECTRICAL DRIER FOR HERBARIUM SPECIMENS


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Contrivances of field botanists, with lanterns and oil stoves to supply heat to dry their specimens have been many and various. These devices could not be used safely in a wooden laboratory. Moreover, circumstances at Clark University made it inconvenient to dry specimens out-of-doors, in the presence of sunlight and an abundance of circulating air, which readily carries off the evaporating water from the plants. Drying indoors has been accompanied by discoloration and mildew, most difficult to combat during humid, stagnant periods and at times tediously slow. Working under these conditions, it became increasingly clear that there must be a better and quicker laboratory means for preparing herbarium specimens. Quite naturally it was reasoned, electricity for heat should be adaptable and without a fire hazard.

After consideration with the University electrician and carpenter, of the difficulties to overcome and the results desired to accomplish, they produced an electrical drier. It is essentially a large wooden box (it might well be of insulated metal) with two full-width doors (no hinges) in front and one forming the top. There are two compartments: the one below for the heat-unit (called in the trade a "space-heater"); that above (the larger) for drying two piles of specimens. Between these compartments, the floor is constructed to support at least 250 pounds, allowing for ample pressing weights sometimes amounting to approximately 100 pounds on each pile of specimens. The piles of pressing specimens are elevated on a rack of 7/8 inch strips, in order to prevent direct conduction of heat into the piles.

The electrical equipment used for heat is simple, consisting of a space-heating unit with thermostatic control.[1] In addition is a Firomatic Thermal Switch, "T.S.100", which will cut out the current completely in case of overheating due to the failure of the thermostat and in case of fire.

The heating compartment, as a safety measure is insulated with asbestos board. As a further precaution against fire, and also to diffuse the heat generated by the unit, a sheet-iron baffle is suspended above the space-heater. This was found necessary to minimize direct heat-conduction, forming an especially hot-spot in the floor beneath the pressing piles.

Mention of measurements is unnecessary inasmuch as details are shown on the accompanying drawing. The construction may be as simple or as varied as the available materials and the ingenuity of the botanist suggest. Two prime requisites are: absolute safety from fire and reasonable control of the ventilation and the temperature. Also, it is desirable to have ample capacity, with space for at least two pressing-piles, each of at least seventy-five specimens, which should accommodate material of more than one collector.

The circulation of heat is by convection only[2]. Entering the heating chamber from below, the air passes upward through a series of ¾ in. auger holes, together with a few slots of the same diameter. The passages, to allow for the expanding air, increase progressively from the intake to the outlet at the top of the drier. Freedon of convection of air into and from the drying compartment appears particularly important. To increase and facilitate this freedom of passage, it has been suggested that a grating beneath the pressing piles would be preferable to the floor with its ventilating holes and slots as now used. Surely there appears no objection to it, except perhaps that it might be a more costly construction. The efficiency of the apparatus appears to be best, if it is installed in a well ventilated room, relatively free from dampness.

[1] Since there are various temperature-control mechanisms designed to accomplish different results, it is advisable to consult an electrician before purchasing. The controller installed is Minneapolis-Honeywell T415A, with a differential. Set to maintain 110° F., this degree is not exceeded. The differential allows this temperature to drop a few degrees before the current is again cut in and the temperature raised to 110° F

[2] An electric fan might be installed to advantage, it has been suggested, in order to obtain speedier movement of the vapor-laden air.

For two years since the initial pressing, the apparatus has given outstanding satisfaction. Colors of both chlorophyll-bearing parts and of inflorescences have been retained, drying surprisingly natural and in many instances superb. Aquatics, most ferns, Cariceae and some grasses, among other plants low in water content, have usually dried overnight; material with more water content has required only twenty-four to approximately forty-eight hours. The drying-time is apparently directly related to the water content of specimens, to the texture, to the atmospheric moisture (humidity) and to the temperature and ventilation within the drier.

It is becoming more apparent why some specimens consume more time to dry than others. Recently, it has been observed that fleshy specimens with glaucum appear to be retarded in drying; in growth, glaucum is said to conserve the plant-moisture. In drying *Arisaema atrorubens* (glaucus) and *Arisaema Stewardsonii* (lacking glaucum) in the same pressing, the *A. Stewardsonii* dried promptly and well, while *A. atrorubens* was slow to dry, requiring more attention to prevent discoloration and crinkling. It is pleasing to find that this genus, ordinarily difficult to press without loss of color, may be preserved with nearly complete natural color, together with much of the glaucum of *A. atrorubens.* Success has also been attained in preserving to some extent, the corrugation of the tube of the spadix of *A. stewardsonii.*

Experience has demonstrated the necessity for efficient pressing materials (pads and corrugated pressing-boards or ventilators). Amelanchier laevis should press easily and dry quickly with clear white petals and slightly rose-tinted leaves. Difficulty was encountered with a specimen recently taken from the drier; it was of good color and quite satisfactory for about two inches from the margins of the pressing-folder. Inside this area, discoloration increased progressively to the center where there was mold. The pressing-boards or ventilators were old and flattened. Their centers probably trapped and retarded the evaporation of the moisture of the plant juices, encouraging growth of molds. Chemical changes within the plant doubtless took place resulting in discoloration of both leaves and flowers. This experience has demonstrated that a pressing-board uncrushed and in good condition would have successfully liberated the moisture, and permitted even drying.

It is no slight satisfaction to find that it is usually unnecessary to change wet pressing-pads and ventilators. Furthermore, as they come from the drier, they are usually ready for re-use without resorting to prolonged spreading in the sun, airing and drying.

After obtaining conspicuously good results with the thermostatic control set at 110° F. without first having known what the optimum conditions for the job might be, an attempt was made to analyze results, in order to determine whether the methods could be improved. Very little information was discovered in print[3]. Practical collectors, however, were quick to warn against too rapid drying, at too high temperature; no one seemed to know the optimum or the maximum safe temperature. High temperature is said to damage tissues and to shorten the life in the herbarium. It has been stated as the cause of the embrittlement of specimens. Professor Fernald[4] refers to the injury done, in his experience, by drying with extreme heat supplied from an engineroom[5] on shipboard during a collecting excursion. Dr. Karl M. Wiegand, explains Professor Fernald, also devised a drying means above the motor of an automobile[6] which he used while collecting. Each method, it is alleged, resulted in fragile specimens; that is embrittlement. Graphically, Professor Fernald continues to explain that the waxy coating (glaucum) of Dr. Wiegand's Magnolia virginiana was melted, completely altering the appearance and obliterating a diagnostic character of the species. Professor Fernald does not indicate the degree of heat utilized, but doubtless it was much higher than he customarily used in pressing.

In an effort to arrive at the normal or perhaps an optimum temperature, the established custom at the Gray Herbarium may

[3] Quite similar in many respects to the electric drier, is the cabinet, seemingly adaptable also to drying specimens, described by Hugh O'Neill, Rhodora, 1938, vol. 70, pp. 1–4, illus., titled, "Heat as an Insecticide in the Herbarium" which utilized a temperature of 170° F. with alleged safety. It resulted after 4–6 hours, in a temperature of 140° F. in the center of the bundles being processed.

[4] M. L. Fernald. Injury to Herbarium Specimens by Extreme Heat. Rhodora, vol. 47, pp. 258–260.

[5] Engineroom temperatures have been estimated by experienced observers as around 120° F. with a probable reduction of the temperature as the air escapes.

[6] Temperatures over an automobile engine would not normally exceed 140° F. and might be less, depending somewhat on driving conditions and variation of the atmospheric temperature.

be considered. There, as with other collectors, it is accepted practice, to place on end, on the cement sidewalk, in full sun, strapped bundles of specimens prepared between corrugated board ventilators. It has been ascertained[7] that the possible range of temperature in Cambridge, on the cement or stone work in front of the entrance to the Gray Herbarium, on favorable drying days, in full sunlight, may range approximately between 120° and 140° F. This most satisfactory estimate is supported by an observation by the present writer, of surface soil temperature about the crowns of Sempervivum growing in a similar situation in Worcester, Massachusetts. In the top half inch of sand, the surface temperature was read at 120° F.

In the drying of plant specimens, a physicist has interpreted a factor, probably quite generally overlooked, but which in reality is the key to the process. Varying with the nature and the bulk of the plant specimens to be dried, is an appreciable amount of water within the tissues. As the water vaporizes, it is picked up and carried off by the air. Almost unbelievable is the physical fact, that one gram of water removed from the specimens, vaporized and expanded, increases in volume one thousand, six hundred times, approximately; that is, a gram of water expands as vapor to about 1.6 liters.[8] The removal of this vast bulk of vaporized water by means of the air is the drying process. Varying with the nature of the material in a given pressing, there may be several grams of water to be picked up and carried off. Obviously, in order to accomplish this readily, the drier should provide free, constant and voluminous passage of air. Conversely, stagnation of the moist, warm air about the succulent plant specimens, in effect slowly cooks them in their own juices and with the accompanying chemical changes, presumably causes discoloration and fading. Such a condition induces and promotes growth of molds, a condition decidedly detrimental to the appearance and life of herbarium specimens. Molds appear to break down the

[7] An appreciated letter, December 30, 1948, from P. H. Kutschenreuter, Meteorologist in Charge, U. S. Weather Station, Logan International Air Field, East Boston, Mass., who interviewed in regard to the problem, Dr. Charles F. Brooks of Harvard University. From his experiments along this line, Dr. Brooks concluded that "under light wind conditions in full sunlight, maximum temperatures on the order of 140° F. were observed; under moderate wind conditions, 120° F." These approximations are of course subject to numerous physical and meteorological phenomena.

[8] Air temperature involves another meteorological axiom. The higher the temperature of the air the greater may be the volume of water-vapor absorbed by it.

plant tissues, being the agent responsible for embrittlement. The sooner, therefore, that the moisture is eliminated, the quicker the drying and the better the resulting specimens. In the construction of the drier, this physical principle of the extraordinary expansion of water, as vapor, should be utilized, with ample provision for the escape of the vapor-laden air.

From the detached data available, as well as by the use of the drier, an approach has been made toward understanding how herbarium specimens may be dried advantageously. An over-high temperature with the consequent over-quick drying and the possible resultant embrittlement of specimens is to be avoided; the over-high temperature it is thought may begin at about 140° F. The electric drier has been operated thus far with much satisfaction at a presumed safe, maximum temperature of 110° F., thermostatically controlled. This may be below the ultimate optimum temperature; near 120° F. is suggested as doubtless safe and very likely efficient. Physical factors point directly to the utilization of as high a temperature as possible. Ideal conditions seem to be temperature and abundant air-circulation as observed out-of-doors in the sun. Outdoor conditions, however, are fluctuating; there are days and circumstances when favorable conditions cannot be available. The electric drier can supplement, if not replace, outdoor drying.

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